

Docket No. 2001-0092-1
USSN 10/036,676

IN THE CLAIMS:

1. (Original) An extreme repetition rate gas discharge laser system capable of operating at pulse repetition rates in excess of 3,000 laser output pulses per second, said laser comprising:

- A) a laser chamber containing a laser gas and having two elongated electrodes, defining a discharge region and having a gas flow path with a gradually increasing cross section downstream of said electrodes to permit recovery of a large percentage of static pressure drop occurring in the discharge region,
- B) a tangential type fan for producing sufficient gas movement of said laser gas in said discharge region to clear from said discharge region, following each gas discharge in said discharge region, substantially all discharge produced ions prior to a next gas discharge when operating at a repetition rate up to and above 4,000 gas discharges per second or greater,
- C) a heat exchanger system removing heat energy from said laser gas,
- D) a pulse power system providing electrical pulses to said electrodes sufficient to produce laser output pulses at rates of up to and above 4,000 laser output pulses per second with precisely controlled pulse energies in the range of about 5 mJ, and
- E) a laser beam measurement and control system measuring pulse energy, wavelength and bandwidth of every pulse or substantially every pulse with feedback control of laser output pulse energy and wavelength.

2. (Original) A laser as in claim 1 wherein said discharge laser system is a KrF excimer laser system and the laser gas is comprised of krypton, fluorine and neon.

3. (Original) A laser as in claim 2 and wherein said chamber also comprises a vane structure upstream of said discharge region for normalizing gas velocity upstream of said discharge region.

Docket No. 2001-0092-1

USPN 10/036,676

4. (Original) A laser as in claim 1 wherein said fan comprises a shaft driven by two brushless DC motors.
5. (Original) A laser as in claim 4 wherein said motors are water cooled motors.
6. (Original) A laser as in claim 4 wherein each of said motors comprises a stator and each of said motors comprises a magnetic rotor contained in a pressure cup separating a said stator from said laser gas.
7. (Original) A laser as in claim 4 wherein said tangential fan comprise a blade structure machined from a single piece of aluminum stock.
8. (Original) A laser as in claim 7 wherein said blade structure has an outside diameter of about five inches.
9. (Original) A laser as in claim 4 wherein said motors are sensorless motors and further comprising a master motor controller for controlling one of said motors and a slave motor controller for controlling the other motor.
10. (Original) A laser as in claim 1 wherein said finned heat exchanger system is water cooled.
11. (Original) A laser as in claim 10 wherein said heat exchanger system comprises at least four separate water cooled heat exchangers.
12. (Original) A laser as in claim 10 wherein heat exchanger system comprises at least one heat exchanger having a tubular water flow passage wherein at least one turbulator is located in said path.
13. (Original) A laser as in claim 11 wherein each of said four heat exchangers comprises a tubular water flow passage containing a turbulator.

Docket No. 2001-0092-1
USSN 10/036,676

14. (Original) A laser as in claim 1 wherein said pulse power system comprises water cooled electrical components.
15. (Original) A laser as in claim 14 wherein at least one of said water cooled components is a component operated at high voltage in excess of 12,000 volts.
16. (Original) A laser as in claim 15 wherein said high voltage is isolated from ground using an inductor through which cooling water flows.
17. (Original) A laser as in claim 1 wherein said pulse power system comprises a resonant charging system to charge a charging capacitor to a precisely controlled voltage.
18. (Currently Amended) A laser as in claim 17 wherein said resonan[ce][t] charging system comprises a de-Qing circuit.
19. (Currently Amended) A laser as in claim 17 wherein said resonan[ce][t] charging system comprises a bleed circuit.
20. (Original) A laser as in claim 17 wherein said resonant charging system comprises a de-Qing circuit and a bleed circuit.
21. (Currently Amended) A laser as in claim 1 wherein said pulse power system comprises a charging system comprised of at least [three][one] power suppl[ies][y] ~~arranged in parallel.~~
22. (Original) A laser as in claim 1 wherein said laser beam measurement and control system comprises an etalon unit, a photo diode array, a programmable logic device, and optics to focus laser light from said etalon unit onto said photo diode array wherein said programmable logic device is programmed to analyze data from said photodiode array to determine locations on said photo diode array of etalon fringes.

Docket No. 2001-0092-1
USSN 10/036,676

23. (Original) A laser as in claim 22 wherein said measurement an control system also comprises a microprocessor programmed to calculate wavelength and bandwidth from fringe data located by said programmable logic device.

24. (Original) A laser as in claim 22 wherein said microprocessor is programmed with an algorithm for calculating wavelength and bandwidth based on measurement of said fringes.

25. (Original) A laser as in claim 24 wherein said microprocessor makes calculations of wavelength and bandwidth faster than 1/4,000 of a second.

26. (Original) A laser as in claim 22 wherein said etalon unit comprises a defractive diffusing element.

27. (Original)A laser as in claim 1 and further comprising a line narrowing unit comprising a tuning mirror driven at least in part by a PZT drive.

28. (Original) A laser as in claim 27 wherein said tuning mirror is also driven in part by a stepper motor.

29. (Original)A laser as in claim 27 and further comprising a pretuning means.

30. (Original) A laser as in claim 27 and further comprising an active tuning means comprising a learning algorithm.

31. (Original) A laser as in claim 27 and further comprising an adaptive feed forward algorithm.

32. (Original)A laser as in claim 27 wherein said line narrowing unit comprises a grating defining a grating face and a purge means for forcing purge gas adjacent to said grating face.

Docket No. 2001-0092-1
USSN 10/036,676

33. (Original) A laser as in claim 32 wherein said purge gas is nitrogen.
34. (Original) A laser as in claim 32 wherein said purge gas is helium.
35. (Original) A laser as in claim 1 and further comprising a nitrogen purge system comprising a nitrogen filter.
36. (Original) A laser as in claim 1 and further comprising a nitrogen purge system comprising a purge module comprising flow monitors said laser also comprising purge exhaust tubes for transporting exhaust purge gas from said laser.
37. (Original) A laser as in claim 1 and further comprising a shutter unit comprising an electrically operated shutter and a power meter which can be positioned in a laser output beam path with a command signal.
38. (Original) A laser as in claim 27 and further comprising a beam seal system providing a first beam seal between a first window of said chamber and line narrowing unit and a second beam seal between a second window of said chamber and an output coupler unit, each of said beam seals comprising a metal bellows.
39. (Original) A laser as in claim 38 wherein each of said first and second beam seals permit easy replacement of said laser chamber.
40. (Original) A laser as in claim 38 wherein each of said beam seals contain no elastomer, provide vibration isolation from said chamber, provide beam train isolation from atmospheric gases and permit unrestricted replacement of said laser chamber without disturbance of said LNP or said output coupler unit.
41. (Original) A laser as in claim 1 wherein said measurement and control system comprises a

Docket No. 2001-0092-1
USSN 10/036,676

primary beam splitter for splitting off a small percentage of the light in each of the output pulses from said laser, a second beam splitter for directing a portion of said small percentage to said pulse energy detector and a means isolating a volume bounding said primary beam splitter, said secondary beam splitter and a window of said pulse energy detector from other portions of said measurement and control system to define an isolated region.

42. (Original) A laser as in claim 41 and further comprising a purge means for purging said isolated region with a purge gas.

43. (Original) A laser as in claim 42 wherein said laser further comprises an output coupler unit and an output window unit said purge means being exhausting from said isolated region also purges said output coupler unit and said output window unit.

44. (Original) A laser as in claim 1 wherein said chamber also comprises a current return having ribs with a generally rectangular cross section with a long direction in a direction of laser gas flow.

45. (Original) A laser as in claim 1 wherein said chamber comprises an anode and dielectric spacers positioned on two sides of said anode to improve laser gas flow in regions between the two electrodes.

46. (Original) A laser as in claim 1 wherein said pulse power system comprises a corona plate electrically connected to capacitors of a peaking capacitor bank and one of said electrodes by metal rods having lengths chosen to provide increased inductance.

47. (Original) A gas discharge laser system comprising:

A) a laser chamber containing a laser gas and having two elongated electrodes, defining a discharge region therebetween and having a gas flow path through the discharge region,

B) a fan for producing sufficient gas movement of said laser gas through said

Docket No. 2001-0092-1

US\$N 10/036,676

discharge region to clear from said discharge region, following each gas discharge in said discharge region, substantially all discharge produced ions prior to a next gas discharge when operating at a repetition rate of up to and above 4,000 gas discharges per second,

C) a heat exchanger system removing heat energy from said laser gas,

D) a pulse power system providing electrical pulses to said electrodes sufficient to produce laser output pulses at rates of up to and above 4,000 laser output pulses per second with precisely controlled pulse energies, and

E) a laser beam measurement and control system measuring pulse energy, wavelength and bandwidth of every pulse or substantially every pulse with feedback control of the laser output, said laser beam measurement and control system comprising a fringe producing optic, a fringe photo detector producing output signals representative of a fringe pattern, a programmable logic device receiving the output signals of the fringe photo detector, and having logic that analyzes the output signals of the fringe photo detector to determine the presence and location of the fringes and provide an output signal representative of the presence and location of the fringes.

48. (Original) The apparatus of claim 47 further comprising:

a computer processor connected to the output of the programmable logic device and programmed to compute one or more of wavelength and bandwidth of the output laser pulse utilizing the output of the programmable logic device.

49. (Original) The apparatus of claim 47 further comprising:

the programmable logic device containing logic to create a fringe look-up table from the output of the fringe photo detector.

50. (Original) The apparatus of claim 48 further comprising:

the programmable logic device containing logic to create a fringe look-up table from the output of the fringe photo detector.

Docket No. 2001-0092-1
USSN 10/036,676

51. (Original) The apparatus of claim 47 further comprising:

the programmable logic device contains logic to identify the optimum set of fringes from the table of fringes for the microprocessor to use in calculating one or more of wavelength and bandwidth.

52. (Original) The apparatus of claim 48 further comprising:

the programmable logic device contains logic to identify the optimum set of fringes from the table of fringes for the microprocessor to use in calculating one or more of wavelength and bandwidth.

53. (Original) The apparatus of claim 49 further comprising:

the programmable logic device contains logic to identify the optimum set of fringes from the table of fringes for the microprocessor to use in calculating one or more of wavelength and bandwidth.

54. (Original) The apparatus of claim 50 further comprising:

the programmable logic device contains logic to identify the optimum set of fringes from the table of fringes for the microprocessor to use in calculating one or more of wavelength and bandwidth.

55. (Original) The apparatus of claim 51 further comprising:

the fringe photo detector comprises an array of photo detector elements each producing an output signal representative of an intensity of light shining upon the photo detector element; and

the look-up table contains the location in the array of at least one pixel comprising a rising edge pixel having at least a selected threshold intensity level and of at least one pixel comprising a trailing edge pixel comprising a pixel occurring after a peak pixel and having at or less than the selected threshold intensity level, for each fringe.

56. (Original) The apparatus of claim 52 further comprising:

Docket No. 2001-0092-1

USSN 10/036,676

the fringe photo detector comprises an array of photo detector elements each producing an output signal representative of an intensity of light shining upon the photo detector element; and

the look-up table contains the location in the array of at least one pixel comprising a rising edge pixel having at least a selected threshold intensity level and of at least one pixel comprising a trailing edge pixel comprising a pixel occurring after a peak pixel and having at or less than the selected threshold intensity level, for each fringe.

57. (Original) The apparatus of claim 53 further comprising:

the fringe photo detector comprises an array of photo detector elements each producing an output signal representative of an intensity of light shining upon the photo detector element; and

the look-up table contains the location in the array of at least one pixel comprising a rising edge pixel having at least a selected threshold intensity level and of at least one pixel comprising a trailing edge pixel comprising a pixel occurring after a peak pixel and having at or less than the selected threshold intensity level, for each fringe.

58. (Original) The apparatus of claim 54 further comprising:

the fringe photo detector comprises an array of photo detector elements each producing an output signal representative of an intensity of light shining upon the photo detector element; and

the look-up table contains the location in the array of at least one pixel comprising a rising edge pixel having at least a selected threshold intensity level and of at least one pixel comprising a trailing edge pixel comprising a pixel occurring after a peak pixel and having at or less than the selected threshold intensity level, for each fringe.

59. (Original) The apparatus of claim 51 further comprising:

the programmable logic device containing logic to identify at least a first fringe comprising a selected fringe positioned within a first window in the array and a second fringe comprising a selected fringe positioned within a second window in the array and to identify at

Docket No. 2001-0092-1
USSN 10/036,676

least the first and the second fringe to the microprocessor.

60. (Original) The apparatus of claim 52 further comprising:

the programmable logic device containing logic to identify at least a first fringe comprising a selected fringe positioned within a first window in the array and a second fringe comprising a selected fringe positioned within a second window in the array and to identify at least the first and the second fringe to the microprocessor.

63. (Original) The apparatus of claim 53 further comprising:

the programmable logic device containing logic to identify at least a first fringe comprising a selected fringe positioned within a first window in the array and a second fringe comprising a selected fringe positioned within a second window in the array and to identify at least the first and the second fringe to the microprocessor.

64. (Original) The apparatus of claim 54 further comprising:

the programmable logic device containing logic to identify at least a first fringe comprising a selected fringe positioned within a first window in the array and a second fringe comprising a selected fringe positioned within a second window in the array and to identify at least the first and the second fringe to the microprocessor.

65. (Original) The apparatus of claim 55 further comprising:

the programmable logic device containing logic to identify at least a first fringe comprising a selected fringe positioned within a first window in the array and a second fringe comprising a selected fringe positioned within a second window in the array and to identify at least the first and the second fringe to the microprocessor.

66. (Original) The apparatus of claim 56 further comprising:

the programmable logic device containing logic to identify at least a first fringe comprising a selected fringe positioned within a first window in the array and a second fringe comprising a selected fringe positioned within a second window in the array and to identify at

Docket No. 2001-0092-1
USSN 10/036,676

least the first and the second fringe to the microprocessor.

67. (Original)The apparatus of claim 57 further comprising:

the programmable logic device containing logic to identify at least a first fringe comprising a selected fringe positioned within a first window in the array and a second fringe comprising a selected fringe positioned within a second window in the array and to identify at least the first and the second fringe to the microprocessor.

68. (Original)The apparatus of claim 58 further comprising:

the programmable logic device containing logic to identify at least a first fringe comprising a selected fringe positioned within a first window in the array and a second fringe comprising a selected fringe positioned within a second window in the array and to identify at least the first and the second fringe to the microprocessor.

Conclusion

No new matter has been added.

Applicants do not believe any fees are due in connection with this submission however, if fees are due, the Commissioner is authorized to charge our Deposit Account Number 03-4060 the appropriate amount.

Respectfully submitted,



William Gray, Reg. No. 27,627

Cymer, Inc.
17075 Thornmint Court
Legal Department - MS/4-2C
San Diego, California 92127-1712
Telephone: (858) 385-7185
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13 of 13